

Wildlife Capability Classification

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Province of British Columbia
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WILDLIFE CAPABILITY CLASSIFICATION FOR BRITISH COLUMBIA : AN ECOLOGICAL (BIOPHYSICAL) APPROACH FOR UNGULATES

D. A. Demarchi

B. Fuhr

B. A. Pendergast

A. C. Stewart

SURVEYS AND RESOURCE MAPPING BRANCH

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Dedication

This technical paper is dedicated to the memory of Alan (Al) John Luckhurst (1937-1975). Al worked as a wildlife biologist in the wildlife sector of the British Columbia Land Inventory Program from 1966 to its completion in 1973. From that time until his untimely death in 1975 he worked for the British Columbia Environment and Land Use Secretariat where he was instrumental in initiating the biophysical wildlife capability classification approach to ungulate habitat evaluation in British Columbia.

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Preface

This accompanying report is intended to generate information on ungulate production that is comparable to information currently being collected for forage production, forests, and agricultural crops. Use of this system will be useful in protecting and managing the province's wildlife resources. The foundation for this program is the biophysical classification system and emphasis is placed on habitat factors rather than on existing wildlife populations. While this report deals specifically with ungulate habitat classification, much of the philosophy and methodology can be applied to other wildlife species.

This approach to capability assessment for ungulate habitat evolved through efforts of the Wildlife Evaluation Unit of the Surveys and Resource Mapping Branch; and Regional Fish and Wildlife staff of the Ministry of Environment who assisted in defining capability class ratings. Victoria staff of the Fish and Wildlife Branch and Research Branch of the Ministry of Forests assisted in editing and reviewing the manuscript. Special thanks to Ray Demarchi, Fred Harper, Ken Sumanik, Glen Smith, Terje Vold, Don Eastman, Rick Ellis and Mike Fenger.

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Figure 20. Aerial view of the study area showing the location of the study area within the larger context of the surrounding landscape. The study area is located in the central part of the image, surrounded by a dense forest. The study area is marked by a dashed line.

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R.J. Challenger Ministry of Forests	
D. Dimarchi	D. Dimarchi





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INTRODUCTION

1.1 THE BIOPHYSICAL PROGRAM

British Columbia has had a wildlife inventory section based on the concept of capability (see Section 2.2 for a definition of land use capability) since the implementation of the Canada Land Inventory (CLI) program in 1965. The Canada Land Inventory program covered the southern two-thirds of the province that was mentioned in the Agricultural Rehabilitation and Development Act (ARDA) (Perret, 1969; and Blower, 1973). Subsequent to the completion of the CLI mapping program and as a result of two integrated resource mapping projects (the Creston Wildlife Pilot Project conducted in 1973 and the Springbrook-Biophysical Pilot Project conducted in 1975), a multidisciplinary inventory approach has been implemented.

A role of the Surveys and Resource Mapping Branch of the Ministry of Environment is to develop classifications that can be used for overall resource capability inventories and resource planning. The biophysical program provides a means for the comparison of all renewable resources by utilizing the same land base information.

Several position papers have been written on the biophysical program. They are listed below for reference purposes.

A. Biophysical Land Capability for Wildlife (Ungulates)

A draft classification of the current approach of separate species rating was prepared by Luckhurst (1975).

B. Biophysical Land Classification in British Columbia: The Philosophy, Techniques and Application

The fundamental philosophies and techniques of the biophysical land classification as it is applied in British Columbia was outlined by Walmsley (1976). He listed three objectives that underlie the biophysical classification scheme: (1) to differentiate and classify ecologically significant segments of the land and water surface, rapidly and at a small scale; (2) to identify opportunities and limitations for particular types or combinations of types of land use, and hence provide a management tool for resource planners; and (3) to relate management practices to land productivity in a qualitative and quantitative manner so that management alternatives can be identified.

C. The Canadian Experience: An Approach Toward Biophysical Interpretation

At an international inventory symposium held in Phoenix, Arizona, Demarchi and Chamberlin (1977) summarized the Canada Land Inventory program as it was applied to wildlife in British Columbia, and outlined the then new ungulate biophysical capability classification.

D. Revised Working Paper on the Methodology and Philosophy of Ecological Land Classification in Canada

The implementation of biophysical concepts in British Columbia established congruency in methods and philosophies with Ecological (Biophysical) Land Classification in Canada (Rowe, 1978).

E. Reconnaissance Biophysical Soil Inventories in British Columbia: A Case Study of the Northeast Coal Area

Vold (1978) presented a case study that provides a realistic application of the biophysical program. In addition, many project reports have been written using the biophysical classification system.

F. Biophysical Land Capability Classification for Wildlife
(Ungulates): Generation II

The first rewriting of the ungulate capability classification with the introduction of environmental condition subclasses was prepared by Demarchi and Fuhr (1979).

G. Biophysical Ungulate Capability Mapping in British Columbia

An updating of the methodology was presented to the Northwest Chapter of the Wildlife Society in Banff, Alberta by Demarchi et al. (1980).

H. The Use of the Biophysical Program and Capability Concepts in
Mapping Ungulate Habitats in British Columbia

A clarification of some of the problems that have been encountered in applying the capability concept to ungulate habitat classification was presented to the Canadian Committee on Ecological Land Classification - Wildlife Section in Banff, Alberta by Demarchi (1982).

I. Forage Capability Classification for British Columbia

A classification for rating forage production, primarily for ungulates (both livestock and wildlife) has been published by Demarchi and Harcombe (1982).

These papers centre on three main concepts in mapping wildlife information for planning and management purposes:

- 1) productivity of land for ungulates can be evaluated in terms of capability as well as existing values;
- 2) food and cover are the primary habitat factors that limit ungulate populations;
- 3) ungulate habitat can be predicted by the interpretation and identification of ecosystem components.

1.2 DIFFERENCES BETWEEN THE CANADA LAND INVENTORY AND BIOPHYSICAL CLASSIFICATIONS

The Canada Land Inventory classification criteria for rating land units was based on a biomass estimate where all ungulates were related to white-tailed deer (Odocoileus virginianus)¹ weight equivalents (Perret, 1969; and Blower, 1973). This biomass estimate provides an estimate of total ungulate production, regardless of the species that could be produced on a given land unit. However, not all species respond to the same habitat stimuli, in fact some species such as mountain goat (Oreamnos americanus) and woodland caribou (Rangifer tarandus caribou) have adapted to habitat types usually having relatively low productivity. As a result the habitats for these species were usually rated low by the Canada Land Inventory classification. At the inception of the biophysical program it was decided that there was merit in providing a capability rating that expressed the capacity of a land unit to produce individual species.

The biophysical ungulate capability classification also differs from the Canada Land Inventory classification system on one other fundamental point. Canada Land Inventory capability maps often list limiting subclasses in conjunction with the capability class rating. This implies that this limiting factor prevents that unit from attaining a higher rating (Hills et al., 1973). However, the limiting factor concept is only practical for either total ungulate biomass or single species biomass classifications. This concept does not work when rating a unit for many species individually. For example, riparian habitats may be most productive in providing total ungulate biomass or even total moose (Alces alces) or white-tailed deer biomasses, but mountain goats will not be found there. Mountain goats have adapted to steep, rocky, terrain where biological productivity is lower. Thus, a factor which is limiting to one species may be an asset to another. In the biophysical ungulate capability classification as with the forage capability classification (Demarchi and Harcombe, 1982), each biophysical

¹ Scientific nomenclature according to Banfield (1974).

unit is assigned an environmental condition factor that best summarizes the dominant biological, physical or climatological processes representing that unit. These environmental conditions are discussed in Section 3.3.

Other comparisons between the two classification systems are based more on the speed with which the inventories are conducted, and the level of interdisciplinary interaction. The Canada Land Inventory program was intended to be conducted at a fairly rapid pace, which meant that the interdisciplinary team approach favored by biophysical mappers was not always practical.

1.3 USES OF BIOPHYSICAL UNGULATE CAPABILITY MAPPING

The concept of assessing the land's capability to produce a renewable resource in addition to assessing its standing crop value has long been recognized for agriculture and forestry (Kowall, 1971; Runka, 1971 and Walmsley, 1976), but has become widely accepted for wildlife only recently. Capability for wildlife was incorporated in the Canada Land Inventory program in the 1960's; the coal guidelines developed for the Environment and Land Use Committee in 1976; and, by British Columbia Hydro and Power Authority for the Seven Mile Dam, Pend-d'Oreille River Agreement also in 1976.

Biophysical ungulate capability mapping has been conducted at various locations throughout the province. Mapping at the 1:50 000 scale has been the most extensive. Major mapping areas include the East Kootenays (27 maps), the Northeast Coal area (31 maps) and the Bulkley/Endako area (21 maps). These areas were undertaken primarily to provide an ungulate capability data base for areas of extensive resource development and/or resource conflicts. Mapping of several smaller areas has also been undertaken in the province. Ungulate biophysical mapping at a scale of 1:250 000 has been conducted to the north of the area covered by the Canada Land Inventory. Approximately 4 maps of this scale are being produced in the Dease/Stikine area. This ungulate capability and associated biophysical

information provide a framework for regional planning and management.

Traditionally, the assessment of present numbers and distribution of ungulates has been the main focus of short term management efforts in the province. However, such assessments often overlook potentially important ungulate ranges where the capability of the land may not be reflected by present animal use. Low ungulate numbers in areas of relatively high capability may be due to unfavourable seral state, conflicting land uses, geographic isolation or biotic factors such as disease or predation. A knowledge of ungulate habitat requirements applied to biophysical base information provides a framework for capability assessment. Presenting capability information in map form illustrates the importance of a particular map unit to ungulates in terms of its location, size, significant environmental conditions present and the relative importance of the unit to the area. This information provides a basis for determining regional and provincial wildlife management strategies and of locating effective management and habitat protection activities. Moreover, because the mapping relies on the combined expertise of wildlife, soils, vegetation, terrain and climate specialists it forms a predictive basis (how to and where) for habitat enhancement. Also, biophysical ungulate capability assessment puts wildlife resources on a comparable basis with forestry and agriculture for land use planning; and, provides a rationale for land acquisition for wildlife, impact assessments, and determining the suitability of areas for ungulate introductions.

1.4 OBJECTIVES

The objectives of biophysical mapping are:

1. to map capability of the land to support ungulates on the basis of habitat factors including soil, terrain, vegetation, climate and other physical and biological parameters;
2. to compare the range of productivities of different wildlife species in a way that relates to their ecological requirements;
3. to provide a rating for each species that can be interpreted in terms of potential carrying capacity.



Plate 1 Current habitat management practices should be ignored by the mapper when rating a land unit on its capability to produce an ungulate species. A fence that separates two different grazing regimes illustrates the need to rate a site on its habitat capability rather than on existing values.

2

THE BIOPHYSICAL UNGULATE CAPABILITY CLASSIFICATION

2.1 BIOLOGICAL PERSPECTIVE

British Columbia is ecologically complex, encompassing eleven biogeoclimatic zones (Krajina, 1969), and has rugged and varied topography. This complexity is reflected in the fauna. For example, the province has eight species of wild ungulates. Two of these species, mule deer (Odocoileus hemionus) and elk (Cervus elaphus) have coastal subspecies with very different habitat niches from the interior subspecies. There are two species and four subspecies of mountain sheep (Ovis dalli dalli, O.d. stonei, O. canadensis canadensis, and O.c. californiana) using widely varying ecological areas.

A common problem to most British Columbian populations is that snow conditions often restrict movement and foraging during winter. Since foraging areas are critical to winter survival, winter range is usually the limiting factor for ungulate populations in British Columbia (Edwards, 1956). However, the ecology of ungulates, like that of many wildlife species, is not completely understood. In some cases other factors such as spring range, migration routes, mineral licks, escape terrain, rutting areas, cover, water and summer range, may be important ecological factors governing wildlife numbers.

Areas utilized in winter often vary widely. Species such as moose, Rocky Mountain elk (Cervus elaphus nelsoni), white-tailed deer and mule deer (O. hemionus hemionus) generally winter in areas with early seral stages of vegetation. These ranges are usually enhanced by disturbance to vegetation from logging, clearing or fire. On the other hand, caribou, black-tailed deer (O. h. columbianus and O.h. sitkensis), and Roosevelt elk (C. e. roosevelti) tend to winter in mature forest communities and thus are usually deprived of critical habitat for many years after forest canopy removal.



Photo Credit: B.C. Water Management Branch

Plate 2 Snow depth is the most important climatic parameter in British Columbia as it limits winter distribution of most ungulate species. Annual snow pack data is important to the biophysical mapper when defining potential ungulate winter ranges.



Plate 3 A complexity of plant communities and/or seral stages can exist on a single biophysical unit. The mapper must establish a rating that not only reflects the plant community which is best for the ungulate being considered but also whether a combination of seral stages might be more beneficial than a single seral stage. The plant community in the foreground will provide winter forage for mule deer while the forest in the background will be used as hiding cover.

Every biological system has limits to its growth. Important limiting factors are those environmental factors that relate to food and cover (Thomas et al., 1979; Dasmann, 1964; and Andrewartha and Birch, 1954). The food and shelter needs of ungulates, both at the individual and at the population level can only be obtained where appropriate combinations of natural features exist. Most important to mapping is the extent to which these needs can be met by a particular environment and are predictable.

Man adds to the complexity of ungulate ecology through impacts such as forestry and livestock grazing. Human use of habitat and the dynamics of vegetative succession imply that the number of ungulates, even when measurable, often does not reflect the potential value of the land for ungulate production.

The biophysical classification can help alleviate some of this ecological complexity through a progressive stratification of the natural features which most affect ungulate habitat. Climatic information can be used to predict snow depth change with elevation, geographic location, and wind exposure. Landforms and surficial material separate the landscape into distinct units with variation in slope, aspect and inherent plant productivity. Soil specialists integrate this information with soil moisture and soil development providing a basis for further interpretations of potential plant productivity. Vegetation zones can be used to predict plant species presence and abundance as well as inferring climatic trends. Seral mechanisms can be described in the context of other biophysical information to provide a predictive basis for present and potential forage and cover production.

Clearly, these ecological features are intimately related in an ecosystem as a whole, and it is this ecosystem in its entirety which must be considered in an ecological (biophysical) classification such as this. The extent to which an ecological classification "works" depends on the degree of integration and understanding of its parts (Walmsley, 1976). Terrain, soil, vegetation and wildlife information should not each be generated in



Photo Credit: B.C. Ministry of Forests

Plate 4 Fire is important in modifying plant communities into those more suitable for ungulates. Although wildfires are no longer acceptable in British Columbia, fire remains the best single method for creating seral shrub ranges and for expanding alpine and grassland environments.

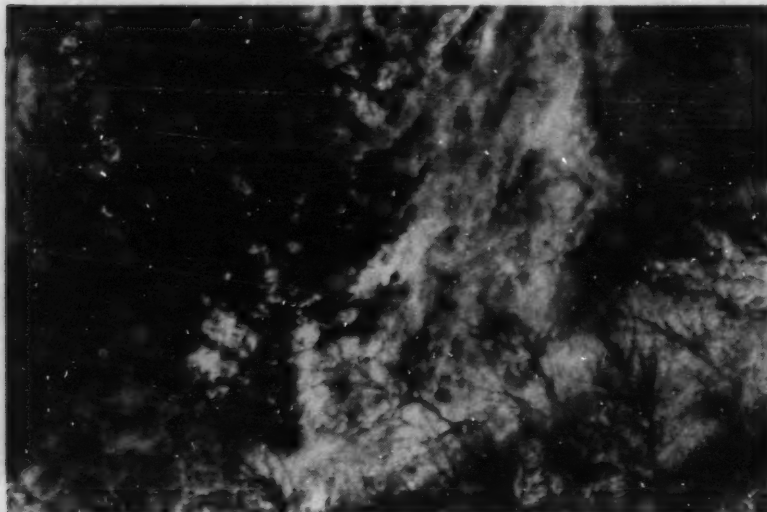


Photo Credit: B.C. Fish and Wildlife Branch

Plate 5 In the absence of wildfire, prescribed burning may be conducted on habitats to achieve the potential of a given ungulate species. Fire will favor the fire dependant and fire resistant plants and will eliminate the fire intolerant ones. Managing of habitats by prescribed fire is considered by a mapper when rating a biophysical unit.

isolation (Taylor, 1979) as this can result in an unworkable product. The accuracy of an ungulate capability classification depends on the accuracy of the biophysical base information as well as the accuracy of wildlife interpretations. In this sense, a wildlife capability map can represent the "state of the art" of wildlife ecology in a particular area since decisions must be made regarding terrain preference, forage preference, period of use, etc. There are analogous assumptions which must be made in other disciplines as well - for example, in the forestry capability classification, desired spacing, stocking rates and species are assumed for each class. Over time incorrect interpretations may be noted which make the maps dated. Some of the older capability mapping in the province is no longer considered reliable in light of new information. This is a problem common to all disciplines as knowledge of ecological processes improves.

2.2 DEFINITION OF LAND USE CAPABILITY

In the British Columbia Ministry of Environment, we use the definition of land use capability as defined by Hills et al. (1973): "land use capability is the potential of an area to produce a specified crop (in this case an ungulate species) under specified technological controls. The level of production is measured in terms of the amount produced, given the kinds and degrees of limitations which prevent any specific land unit from reaching maximum production."

We assume that only non-intensive habitat management options are available to the wildlife habitat manager, such as: prescribed burning or fire protection; prescribed grazing by cattle; and, prescribed logging or slashing. In addition, animal harvests or protection are not considered to have an effect on the ability of the habitat to support ungulates. The level of management functions largely to maintain the native vegetation community at its optimal seral state for the species under consideration and that the measures prescribed must not degrade the land base for production of the seral stage chosen.

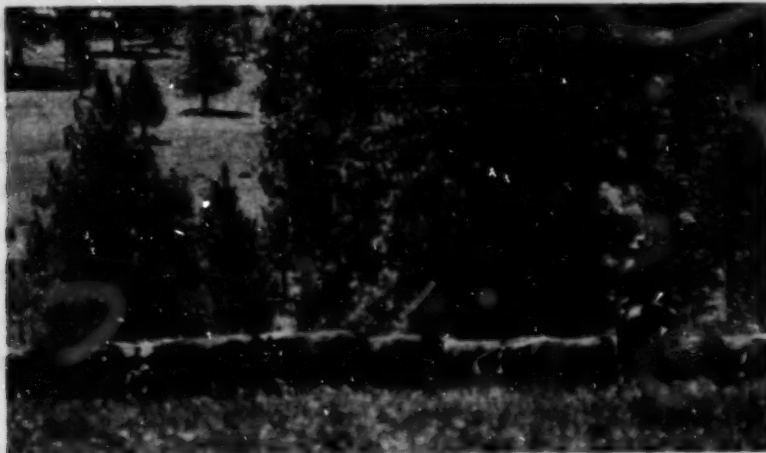


Plate 6 Controlled livestock grazing can be a tool to stimulate herbage production of some forage plants that are vital to the survival of some ungulate species. Deferred grazing is one such scheme that will ensure proper grazing levels; these steers are being moved out of this pasture now that the proper grazing level of Idaho fescue has been achieved.



Photo Credit: B.C. Ministry of Tourism

Plate 7 Logging can be used to eliminate or modify the forest canopy to favor early pioneer seral plants and therefore ungulate species which prefer such forage. As a management tool, logging should be used to create openings in the forest of a size favoured by the species being managed.

Management is different for each discipline that uses the capability concept. For ungulate classification, management is non-intensive. In the case of agriculture capability, intensive practices such as irrigation, fertilization, spraying, dyking, drainage and winter feeding are acceptable.

2.3 THE BIOPHYSICAL CLASSIFICATION CONCEPT

The biophysical classification system has its foundation in the ecological formulation presented by Jenny (1941) and Major (1951). They believed that both soils and vegetation were a function of climate, geologic parent material, relief, organisms and time. Each factor can be analyzed or determined and its contribution to the function of an ecosystem can be evaluated.

Using the biophysical classification concept in a mapping program can be viewed as a building block process that encourages the synthesis of physical and biological data (landforms, materials, soils, climate, vegetation and organisms) to form "ecologically significant" units of the landscape (Walmsley, 1976). The process of delineating these units involves the identification of various phenomena each of which is an end-point for the appropriate discipline, but when combined provides the basis of the biophysical map unit. Each unit which is judged to have different carrying capacities and opportunities for supporting ungulates is designated as a map unit and is given a capability rating for each ungulate species that can occur there. Guidelines for potential species occurrence are presented in Biotic Regions of British Columbia (Demarchi, in prep.). Thus, land units with similar potential, and biological productivity are identified by using an ecologically based, integrated soils and vegetation program.

2.4 UNGULATE CAPABILITY CLASSES

The ability of the land to support a species is expressed as one of six classes; very high, high, moderate, low, very low and no capability for the



Plate 8 Precipitation and temperature are environmental parameters that must be measured when distinguishing vegetation zonation, soil development, forage production and limitations to the survival of individual ungulate species.



Plate 9 Each land unit must be related to others of similar biophysical character. The determination of surficial materials, terrain features and soil processes is necessary for the mapper to assess biological production and similarities between sites.

production of ungulates. Class 1 ratings apply to the best areas for each ungulate species in the province.

The class 1's for each ungulate species were assigned following consultation with regional wildlife biologists and from information available in the literature (Peek *et al*, 1974; Anderson and Scherzinger, 1975; Sumanik and Demarchi, 1977; and Amara, 1978). The potential carrying capacity of the lower classes is expressed as percentages of the values in class 1 (Table 1). For example, class 2 has 75% class 1 capability. Class 1 was subdivided to provide for areas with exceptionally high capability (these are termed super classes). Three super classes have been used to date, the higher two of these (super class 1B and 1C) having carrying capacities of 25% and 50% greater than class 1 (1A). These super classes were established in order to provide an equitable province-wide rating scale. If the most outstanding area of the province (perhaps Premier Ridge in the East Kootenays) was a class 1 rather than a superclass, there would be no other areas of class 1 in the province for some species.

Carrying capacity estimates are measured in units of animals per square kilometre per year. Therefore ranges that are not used year-round must support proportionally higher animal numbers to achieve the same rating as year-round ranges. For example, a land unit that can support 5.3-7.0 goats/km² year-round is a class 1 range; a winter range that is used for six months must be able to support 10.6-14 goats/km² in order to be rated as a class 1 winter range.

2.5 SCALE OF MAPPING

Wildlife capability mapping like other disciplines in the biophysical inventory program can be conducted at a variety of scales. To a certain extent available base maps limit the choices (i.e. 1:50 000 or 1:250 000 published maps). The scale chosen also reflects the objectives of the inventory and time necessary to survey an area. Consistent with the Mapping System Working Group's (1981) recommendations (see also Fenger,

TABLE 1
POTENTIAL CARRYING CAPACITY ESTIMATES (ANIMALS/SQUARE KILOMETRE/YEAR)
FOR UNGULATE CAPABILITY CLASS RATINGS¹

Classes ¹	Capability	Black-tailed Deer	Mule Deer White-tailed	Mountain Sheep	Elk	Caribou	Mountain Goat	Moose
1C		33.9-40.5	26.4-31.5	20.1-24.0	16.4-19.5	12.6-15.0	8.8-10.5	7.6-9.0
1B	very high	27.1-33.8	21.1-26.3	16.1-20.0	13.1-16.3	10.1-12.5	7.1-8.7	6.1-7.5
1A		20.4-27.0	15.9-21.0	12.1-16.0	9.9-13.0	7.6-10.0	5.3-7.0	4.6-6.0
2	high	13.7-20.3	10.7-15.8	8.1-12.0	6.6-9.8	5.1-7.5	3.6-5.2	3.1-4.5
3	moderate	6.9-13.6	5.4-10.6	4.1-8.0	3.4-6.5	2.6-5.0	1.8-3.5	1.6-3.0
4	low	1.5-6.8	1.2-5.3	0.9-4.0	0.8-3.3	0.6-2.5	0.4-1.7	0.4-1.5
5	very low	<1.4	<1.1	<0.8	<0.7	<0.5	<0.3	<0.3
6	none	0	0	0	0	0	0	0

¹ Ranges calculated using the maximum of Class 1A as 100%. Classes 5 to 1C respectively are: <5%; 6-25%; 26-50%; 51-75%; 76-100%; 101-125%; 126-150%. The use of decimals is to prevent rounding errors; an estimation of carrying capacity to this accuracy is not expected.



Plate 10 Hunting does not affect the capability of a land unit to produce ungulates and does not affect ungulate capability ratings.



Plate 11 Direct mortality and disturbance caused by highways and railroads are not considered in a capability rating.

1982), wildlife capability mapping is conducted at one of two scales, each with a specific level of field sampling (or intensity).

- a) small scale inventory (1:250 000). Useful for planning and habitat protection at a generalized level. This mapping is done largely through remote sensing with some on-site inspections. Traverses by surface vehicle and helicopter are from 8-20 km apart. Biophysical units are extrapolated from aerial photographs with a soil inspection in 30% of the units.

Biophysical data base consists of: physiographic subdivisions (based on bedrock geology and landforms); vegetation zones and subzones; dominant surficial material and landforms; identification of active geomorphic processes; and soil moisture regime and drainage.

- b) 1:50 000 (standard inventory). A level of detail used in land use planning such as regional resource plans and for selecting sites for habitat management at a generalized level. On-site inspections are made on all significant terrain and soil types. Traverses, mainly by vehicle but with some foot travel and helicopter use are from 2-4 km apart; helicopter use is essential in mountainous areas. Biophysical units are checked in the field, but are mainly extrapolated from aerial photographs with soil inspections in 60-80% of the units.

3

MAPPING PROCEDURE

3.1 INTRODUCTION

Ungulate biophysical mapping is a stepwise procedure of integrating the salient ecological features of a landscape with ungulate habitat requirements. These steps include the gathering of existing biophysical and wildlife data, the filling of necessary data gaps, the delineation of units significant to ungulates and the assigning of appropriate capability ratings to those units. The following sections of this chapter discuss this procedure.

3.2 COLLECTING EXISTING DATA

To collect existing wildlife and biophysical information, a search of published or unpublished inventory information is made with Fish and Wildlife Branch offices, the Surveys and Resource Mapping Branch offices, Ministry of Forests offices and others where appropriate. Interviews are conducted with regional and headquarters Fish and Wildlife Branch staff, guides/outfitters, trappers, long time residents and other people with knowledge of an area's present and/or former wildlife distribution. The assemblage of this information provides a starting point in planning data needs, field scheduling and budgeting.

3.3 THE DELINEATION OF UNITS

A map symbol is composed of two parts: the ungulate capability rating and the environmental conditions relating to the unit (see Figure 1). Either of these parts can be used to separate one unit from another. Rough mapping (pretyping) is conducted on the basis of existing data and interpretation of aerial photography prior to field data collection. It is important to use aerial photographs of the appropriate scale. Most map



Plate 12 Personal interviews with local wildlife experts provides useful information about an area. When conducting a survey it is important that the mapper obtain information on historical as well as current ungulate use.



Plate 13 Aerial photographs provide a general overview and are valuable in making specific habitat interpretations in inaccessible areas.

units are derived from terrain, soil, vegetation, and climate maps. Some biophysical boundaries may be omitted if they are of little significance to wildlife or added if unmapped boundaries affecting wildlife are identified. If base mapping is not available, some pretyping should be done on aerial photographs. Usually one source of biophysical map information is selected to be the dominant map base on which interpretations are made. This is generally an ecologically based soils map since this provides a high level of ecological integration as described in Walmsley, 1976. Vegetation maps can also be used, provided interpretations of potential forage production can be made from them. Terrain maps do not provide information on soil moisture or climatic change and are not adequate by themselves.

The most significant factors leading to the assignment of a capability class to a biophysical map unit are termed environmental conditions. Symbols which are used to represent these conditions on the maps are shown in Figure 1. A complete list of environmental condition descriptions appears in the Appendix. These conditions may relate to forage productivity, cover or any other characteristics which influence the ability of the land to support a species. Environmental conditions are presently listed in four categories: (1) climate, (2) anthropogenic (human) factors (3) landforms and terrain, and (4) soils. The list is not finite and is subject to modifications or additions to suit specific areas. Pretyping using environmental conditions may be used even if a capability rating has not yet been determined. This may be useful in gaining an ecological perspective of an area and in stratifying field sampling.

3.4 DETERMINING CAPABILITY RATINGS

During the summer, field work is conducted to assess importance of the various habitats in the study area. Methods of collecting field data are described in Section 3.6. Additional field observations are made during the winter to confirm the use and extent of winter ranges. Usually the inventory team conducts a broad overview of the study area by road, aircraft or other means of travel. Sites representative of most biophysical units in



Plate 14 The assessment of the potential ungulate use of a biophysical unit includes the determination of the current use of existing plant communities and then relating that information to the projected use of potential habitats. One technique used to assess current ungulate use is to count pellet groups deposited by each ungulate species over a specific area.



Plate 15 The ungulate capability rating of a land unit is related to its potential forage production. Total clipping and weighing of all herbage and browse species is important in determining the relative worth of a plant community to an ungulate species.

the area are selected for more detailed analysis. Areas of special importance are winter ranges having a favourable successional vegetation stage and ungulate use near present carrying capacity, as judged from range use intensity. These areas may be used to substantiate capability estimates on similar biophysical types which do not have a favourable seral state and/or ungulate use. They may also be used as bench-marks against which different biophysical types can be ranked.

The capability classification describes the theoretical carrying capacity (biomass) in terms of animals/square kilometre/year.

Example: One square kilometre of class 3 elk winter range can support an average of 5 elk/km²/year or 60 elk/km²/month (e.g. range given on Table 1)

Capability classification does not state the length of time that the unit of land is used. In the above example, if the unit is used for the entire year by a resident population, then the capacity population is 5 elk. If these elk were migratory and used adjacent summer range for half of the year, then the wintering capacity population would be doubled to 10 elk.

The above case of a purely resident or migratory population seldom occurs in natural systems. In most cases it would be difficult to determine how many animals are on a winter range during the summer. The multiplication of a wintering unit's area by the designated species carrying capacity (animals/km²/year) results in a minimum capacity population (as a resident herd is assumed). If information pertaining to seasonal habitat use is available, appropriate factors should be applied. Winter range capability classes are usually class 4 or higher. Class 5 winter ranges are not mapped because of the difficulty of predicting very low use winter areas.

Summer range values are assessed from the degree to which they contribute to the total production of a given species. Without available winter range, summer range is of no value to ungulates and is not assigned a capa-



Plate 16 Cover requirement is one of two fundamental uses that ungulates make of habitat; the other is foraging. This mule deer is avoiding a strong wind.



Plate 17 Steep slopes limit habitat use by some species but are preferred by others. This stone sheep is foraging on a slope that is too steep for many other ungulate species. The environmental condition symbol Ls (steep slopes) would be used on a unit dominated by such topography.

bility rating. During summer, forage is normally abundant. One effect of summer range use on an ungulate population is that it reduces foraging pressure on the species' winter range. For these reasons, summer range ratings cannot be related to forage productivity as is done for winter habitat but are rated on an "importance" value for the potential of a given habitat to produce a species. Summer ratings should, however, be based on forage production if this is thought to be limiting. Forage production is only one aspect of the importance value for a species. Summer capability ratings are usually class 3 or less because summer populations are often dispersed over large areas and have a short habitat use period.

Capability ratings are made for each species independently, assuming the optimal seral state for each species. The sum of combined capabilities then is not a measure of the land's total productivity. The ratings are made for each species independently since to do otherwise would require a management decision on the proportion of each species desired in the total ungulate population. Thus assessment of combined capability ratings (i.e. estimating competition) is not included on biophysical capability maps. The combined species ratings may be evaluated in accompanying reports if requested by managers and they provide the necessary management objectives.

Currently, capability ratings reflect the single seral stage that will provide the highest density for each ungulate species. Another option exists, that is, to rate the ungulate capability for each species for each of the major seral stages of a plant association. Such a rating would provide wildlife managers with more information on the dynamics of ungulate production. Due to the complexity of ecosystems it would be more suitable to present such a rating as a map narrative or as an attribute in a table of vegetation landscapes rather than as a mapped item.

Map units are evaluated on the basis of their position in the ecosystem as a whole in order to assign capability ratings. Thus, factors such as the proximity of seasonal ranges and behavioural characteristics of each species are taken into account when assigning capability ratings to a map unit. For



Photo Credit: B.C. Fish and Wildlife Branch

Plate 18 The removal of vegetation, soil and underlying surficial materials constitutes a drastic alteration of the natural environment. Ungulate capability assessment of sites such as this open-pit mine and over-burden deposit must be made in consideration of the destructive impact. The national, inherent capability has been altered and a new set of environmental parameters now exists. The environmental condition symbol for industrial development is Hi.

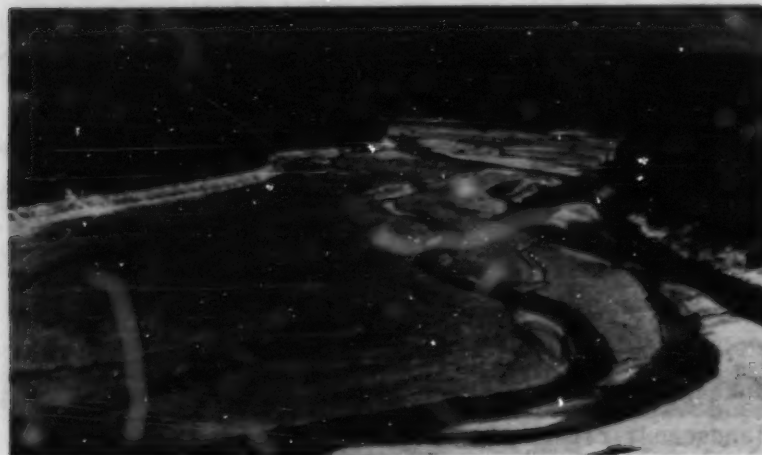


Photo Credit: Aquatic Studies Branch

Plate 19 Like deep lakes, reservoirs are not rated for ungulate capability. The mapper must however, assess the capability of the draw-down zone to produce forage. The environmental condition symbol for reservoirs is Hh.

example, two map units essentially alike in all accounts except their proximity to escape terrain would be assigned different ratings if this factor differentially affected their use by a species and therefore their ability to support that species.

Capability ratings reflect only biological and physical parameters of the environment as they relate to wildlife species for which the land is classified. Social and economic parameters are ignored as are needs of other species. Similarly, capability ratings do not generally reflect present land use, ownership, lack or ease of access, distance from settlements or hunting pressure, providing these factors do not affect the capability of the land base.

When the land base is permanently affected in a major way, the ratings reflect the modified capability and the symbol for anthropogenic factors is applied. Land which has been 'permanently' altered (according to the discretion of the mapper) by incompatible uses is classed as having lost its natural capability to support wildlife. If the soil of a site has been changed, then the capability of that site has been altered and a new site potential must be established. Disturbance by noise, human presence or other ephemeral factors are not considered to have an effect on a site's capability.

When rating farmland it must be understood that a farmed site has been altered by plowing and fertilization and the natural capability of that site is no longer relevant. However, livestock grazing and other less intensive farming activities are not considered to have an effect on a site's capability. Any land unit that has been permanently altered from its natural state, is rated on its new site potential rather than its now unachievable, past potential.

Preliminary wildlife capability maps and map legends are drafted after the survey team has returned from the field. The maps are cross-checked and border matched by the project coordinator and reviewed by regional wildlife



Plate 20 Agricultural practices have variable effects on the inherent capability of a land unit; livestock grazing usually has no effect, while intensive plowing and drainage alters the site considerably. The mapper must consider each agricultural activity in the context of how the natural ecosystem has been altered and a new one developed. The environmental condition symbol for cultivated land is Hc.



Plate 21 Urban development alters the capability of an area to produce ungulates. Urban areas are rated on their ability to produce ungulates in their current state. The environmental condition symbol for urban development is Hu.



Plate 22 Highways and railroads alter the ability of a unit to produce ungulates. Some biophysical units are completely obliterated by transportation corridors; other units are only partially affected. The mapper must assess the degree of impact on capability by estimating the proportion of the unit directly affected. The environmental condition symbol for highways and railroads is Hr.

FIGURE 1. A simplified example of a Biophysical Wildlife (Ungulate) Capability map legend, for use with Figures 2 and 3.

Map Symbol	
Capability Rating Ungulate Species $\rightarrow X^{123}M^4W^4$ $\xrightarrow{\text{Lf Sm}}$ Environmental Conditions Superscript rating indicates winter range Subscript rating indicates summer range	
Ungulate Species Symbols	
X... Moose	M... Mule Deer
E... Elk	B... Black-tailed Deer
W... White-tailed Deer	C... Caribou
G... Mountain Goat	S... Mountain Sheep
Capability Classes	
CLASS 1: Lands in this class have very high capability to support the assigned ungulate species. When required, this class may be subdivided on the basis of productivity into classes 1a, 1b and 1c. CLASS 2: Lands in this class have high capability to support the assigned ungulate species. CLASS 3: Lands in this class have moderate capability to support the assigned ungulate species. CLASS 4: Lands in this class have low capability to support the assigned ungulate species. CLASS 5: Lands in this class have very low capability to support the assigned ungulate species. CLASS 6: Lands in this class have no capability to support the assigned ungulate species.	
Environmental Conditions	
CLIMATE Pa - RAIN SHADOW Sh - HIGH SNOW Sm - MODERATE SNOW Sl - LOW SNOW Ss - INTENSIFIED SOLAR RADIATION Sv - WINDSWEEP SNOW Sp - SNOWFIELDS AND GLACIERS Tc - COLD AIR LAYER Tw - WARM AIR LAYER Tf - FROST POCKETS Th - HIGH HEAT Ta - ALPINE ARIDITY We - EXPOSURE ANTHROPOGENIC Hu - URBAN DEVELOPMENT Hi - INDUSTRIAL DEVELOPMENT Hr - TRANSPORTATION CORRIDORS Hh - RESERVOIR DRAW-DOWN ZONE Hc - CULTIVATED LAND	SOILS AND LANDFORMS La - AVALANCHE TRACTS Le - SOIL EROSION Lw - FAILING SLOPES Ls - STEEP SLOPES Ll - LEVEL LAND Lr - ROLLING OR HILLY LAND Lf - ACTIVE FLOODPLAIN Li - FRESH WATER INUNDATION Lt - TIDAL INUNDATION Ef - UPLAND FOREST SOILS Ed - OPEN FOREST SOILS Eg - GRASSLAND SOILS Em - SUBALPINE MEADOW Es - ORGANIC SOILS Et - TALUS Er - BEDROCK Eb - ALKALINE SOILS Es - SALINE SOILS Eh - MOIST SOIL Ex - DRY SOIL Ew - DEEP FLUVIAL DEPOSITS Fl - DEEP LACUSTRINE DEPOSITS

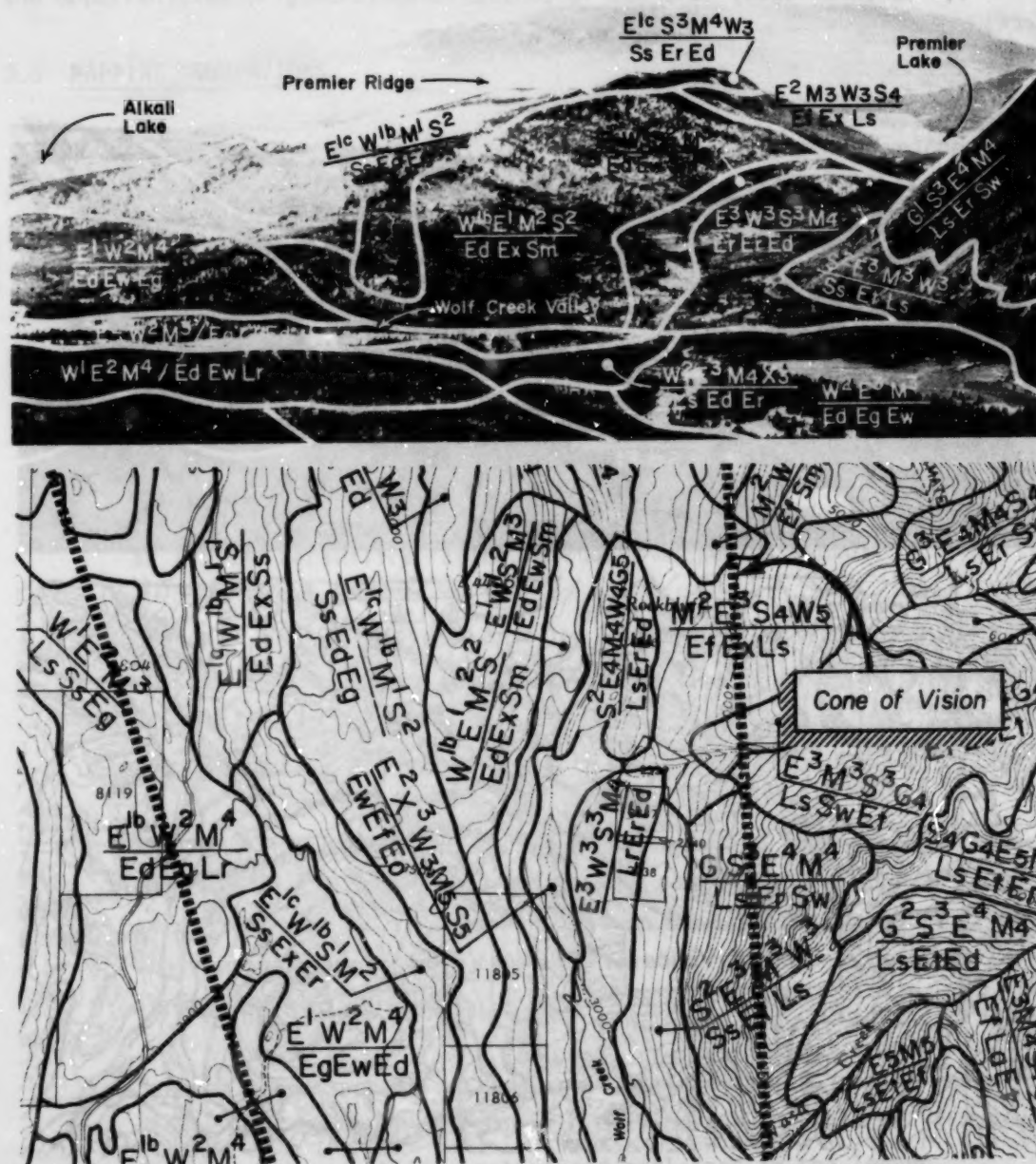


FIGURE 2 Stratification of a landscape into Biophysical Units with subsequent Ungulate Capability Ratings, at a scale of 1:50 000. The photo and the map represent the same general area (photo is not to scale).

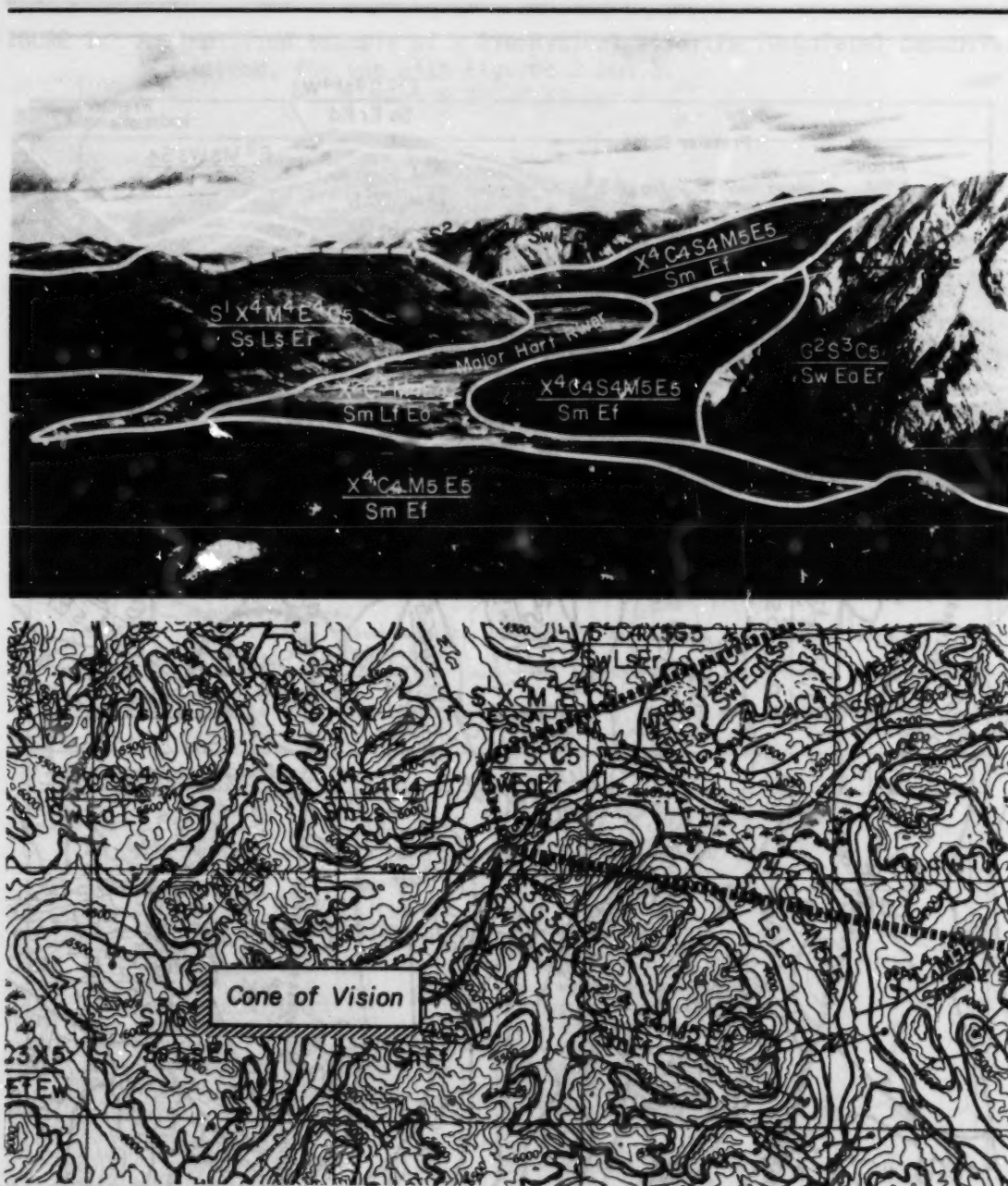


FIGURE 3 Stratification of a landscape into Biophysical Units with subsequent Ungulate Capability Ratings, at a scale of 1:250 000. The photo and the map represent the same general area (photo is not to scale).

biologists. Reports prepared at this time include management constraints and opportunities or general descriptions of the area (e.g. Fuhr, 1980).

3.5 MAPPING CONVENTIONS

A set of mapping guidelines or conventions has been developed to provide a consistency of approach. Most of these are evident in Figures 1, 2 and 3; others are listed here.

1. Ungulate species are shown in upper case letters and listed in order of their rating, where two species have the same rating no preference is implied by order of their listing.
2. Capability classes are shown in Arabic numerals; superclasses are designated with upper-case letters (class 1A is usually abbreviated as 1); the capability rating follows the species symbol.
3. Seasonal use of a land unit by a species is indicated by the position of the capability class number. A superscript designates a winter range, while a subscript designation means that the unit is not a winter range.
4. Environmental conditions are shown in upper and lower case letters; they are placed under the species and capability rating and separated from them by a horizontal line; where two or three condition descriptions are used, they are listed in decreasing order of importance.
5. Special areas such as rutting areas, calving areas, spring range or others may be denoted by special symbols (such as an asterisk) following the capability rating and explained in the legend.

These forms and nomenclature descriptions are available from Maps, E.C., Survey and Resource Mapping Branch, B.C. Ministry of Environment, Parliament Buildings, Victoria, B.C. V8V 3A5.



Plate 23 Glaciers and permanent snowfields constitute habitats whose only use to ungulates are for insect or summer heat avoidance. The map notation for no ungulate capability on a glacier or snowfield is

$\frac{6}{Sp}$.



Plate 24 A mineral lick represents a unique habitat type that is much smaller than most biophysical units. A symbol $\textcircled{L}$ on maps represents a known mineral lick.

3.6 COLLECTING FIELD DATA

The Ministries of Environment and Forests have a series of site, soils, vegetation and wildlife description forms¹ for ecological descriptions. These include forms for the description of site, soil, vegetation, mensuration and wildlife. For details and user instruction for these forms see Walmsley et al. (1980); Sondheim et al. (1982) and Pendergast et al. (1982). These forms should be used for all ecological data collection in the province. The wildlife description form is designed for site specific evaluation of wildlife habitat and populations. Use of all the forms at each site will provide relevant information on the location of the site, its physical parameters, information regarding the biological productivity i.e. soil development and plant communities, as well as current use i.e. browsing assessment and grazing level ratings.

In addition to data collected on a site specific basis are aerial surveys designed to inventory large tracts of land quickly - usually by use of either a helicopter or fixed-wing aircraft. Helicopters are used in areas of extreme topographic relief or in areas with very high wildlife concentrations. Fixed-wing aircraft are usually used for general overviews. For ungulate capability mapping projects, the landscape is searched systematically to assess relative abundance of ungulates. Survey stratification is based on existing ungulate information, the location and inter-spersion of biophysical types, and on current survey conditions.

Survey crews usually consist of the pilot and two or three observers. One of the observers sits next to the pilot as navigator. It is important to use topographic maps of appropriate scale showing any predetermined flight lines. The navigator records ungulate species, numbers, and other animals sighted directly onto the topographic maps. During winter surveys, track abundance (by species where identifiable) and depth of snow are also

¹ These forms and methodology descriptions are available from: Maps-B.C., Surveys and Resource Mapping Branch, B.C. Ministry of Environment, Parliament Buildings, Victoria, B.C. V8V 1X5.

recorded. All relevant information is recorded on maps in abbreviated form as in Figures 4 and 5.

A second observer indicates appropriate sightings to the observer-navigator who records the information on the map, as well as recording a variety of other pertinent information on a tape recorder. This information includes the following:

- name of pilot and aircraft type
- names of observers
- relevant weather conditions
- times of take-offs, landings, and reference points
- significant ecological information, used mainly to assist later mapping and clarification
- wildlife observations including time, species, number of individuals (or sign), sex and age, elevation, habitat description, behaviour and location.

During the survey, on-the-ground checks are made of accessible areas to 'ground truth' environmental and habitat information such as snow depths and forage utilization.



Plate 25 Aerial transportation is used to access isolated areas, to observe many habitats quickly and to census ungulates currently using a particular habitat. Most ungulates are counted in mid-winter when animals are concentrated on winter ranges. Some species such as mountain goats, may be counted in summer when they are most visible.



Plate 26 Direct observation of ungulates using specific habitats is useful for the mapper to assess the value of existing habitat.



FIGURE 4 Observation Map, showing the results of an Aerial Inventory scale of 1:250 000.

SPECIES	SYMBOL
Mule Deer	O
Black-tailed Deer	B
White-tailed Deer	W
Moose	X
Caribou	C
Sheep	S
Elk	E
Goat	G
Wolf	WO
Grizzly	GB
Black Bear	BB

A herd of 12 caribou would be indicated at C₁₂, two moose as X₂, etc.

OTHER ANIMALS SEEN

Coyotes } recorded as
Furbearers } actual (e.g.
Domestic Livestock } 2 wolverines)

TRACK ABUNDANCE	SYMBOL
Nil	N
Few	F
Moderate	M
Plentiful	P

Track abundance may be shown as N/F (nil to few), F/M (few to moderate), etc. Species indicated in brackets (e.g. F(G) = few goat tracks) unless obvious. "Old" after track abundance indicates earlier use, e.g. M (old) means moderate use but that the tracks are not fresh.

In some cases the number of animals will be estimated by tracks. This is indicated using the symbol T and in brackets the species symbol and estimated number. For example:

T(C4) = herd of 4 caribou
 estimated by tracks
T(WO9) = pack of 9 wolves
 estimated by tracks

ESTIMATED SNOW DEPTH	SYMBOL
Nil	N/S
Trace (e.g. patching or windswept)	Tr/S
0.25 m of snow	.25/S
0.5 m of snow	.5/S
1.0 m of snow	1.0/S
1.5 m of snow	1.5/S
over 1.5 m of snow	1.5+/S

Actual snow measurements are indicated by a circled symbol e.g. a measurement of 0.9 m would be indicated as 0.9/S

OTHER SYMBOLS

-  - Lick
-  - Start of Flight Line
-  - Termination of Flight Line
-  - Helicopter landing site
-  - Flight direction and path
-  - Summer Trails

FIGURE 5 Map Symbols for use with Wildlife Surveys and Field Maps

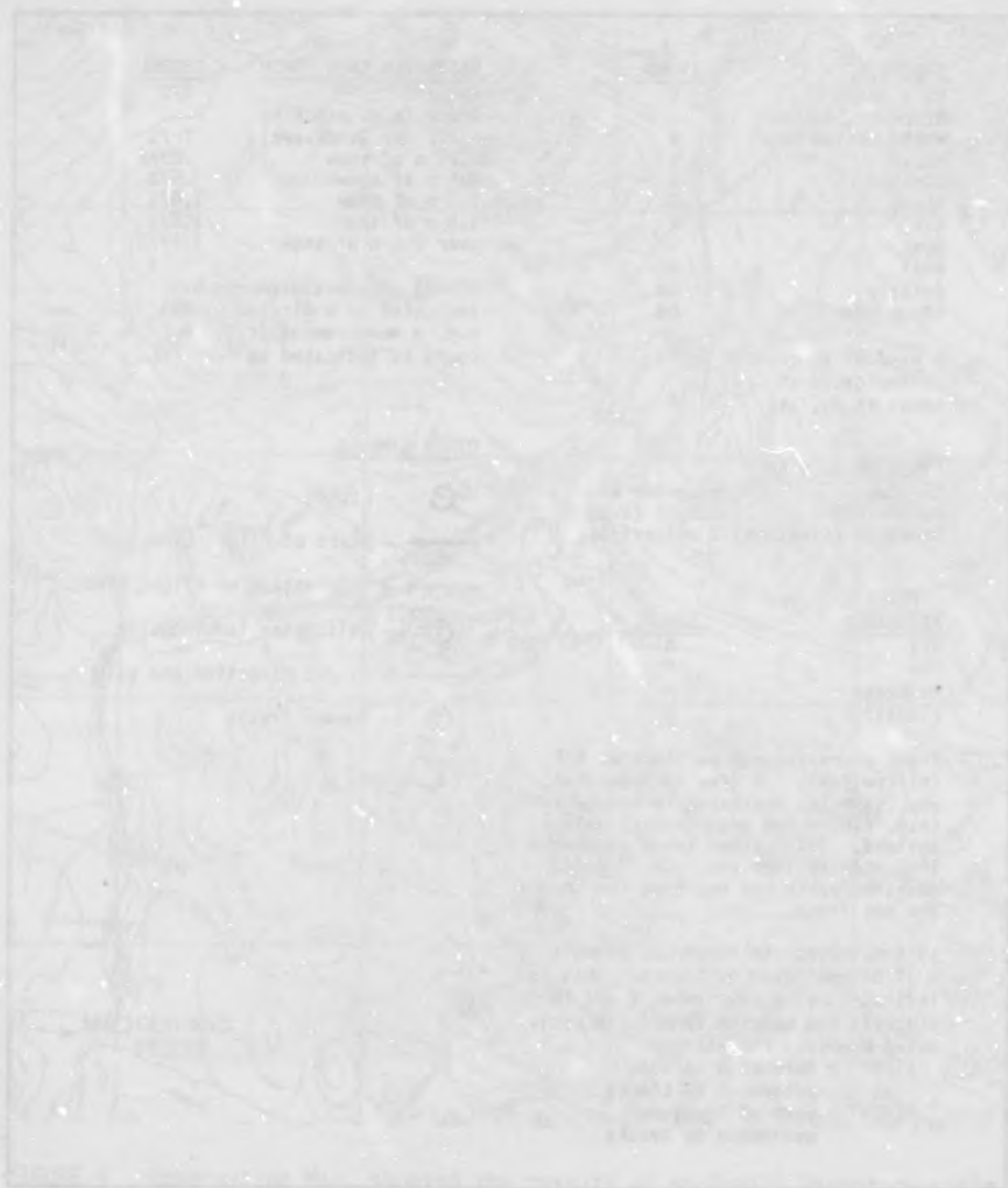


FIGURE 1. The distribution of the various bird species in the United States.

4

SUMMARY

The assessment of ungulate capability was first applied in British Columbia by the Canada Land Inventory program in 1965. While the concept of assessing the capability of the land to produce ungulates has remained, the method of presenting this information has changed. A major philosophical change occurred in the mid-1970's when the biophysical concept was introduced. This relies on the principle that the degree to which habitat meets the needs of wildlife can be predicted by an identification and interpretation of ecosystem components. The biophysical base information on which ungulate interpretations are made includes climate, landform, surficial material, soil and vegetation. An integration of this data provides the most reliable predictive and defensible information on which to base ungulate capability estimates.

The following points summarize the biophysical ungulate capability classification methodology:

1. The land surface is separated into repeatable ecological units based on physical and biological characteristics reflected by terrain, soil and vegetation parameters. The most important ecological features relating to ungulates are termed 'environmental conditions'.
2. Each unit is assigned a capability class on the basis of all known or inferred information about the unit, including soil parameters, surficial materials, climate, vegetation, ungulate species behavior and productivity.
3. Capability for ungulate species is considered as the maximum number of animals of each species that can be sustained on a biophysical unit under assumed management practices; capability

classes are an expression of the number of each species that can be supported on a square kilometre of that biophysical unit for a period of one year.

4. The capability classification considers that some human activities have permanently altered the potential of some land units to produce forage. The land is rated on its new potential rather than on its past potential.
5. The capability classification reflects the ability of the habitat in a potential successional stage to support ungulates; hunting, disease, predation and other mortality factors are not considered to have an effect on the habitat's ability to support animals and therefore these factors are not considered when applying a rating.

The presentation of wildlife capability and habitat information in map form has numerous advantages. It illustrates the location, size and relative importance of a unit to an area. This has obvious application to the formulation of habitat protection and enhancement strategies as well as wildlife management and impact assessment.

The common practice of attempting to assess current numbers for impact assessment purposes has frequently been frustrated by the difficulty in conducting an accurate census. Temporal variations in current use contribute to this variability, as exemplified by the Site C hearings (Ministry of Environment, 1982). Some estimation of current use and numbers is useful, however, in addition to ungulate capability assessment, in order to provide both the current and option value of the resource necessary for a complete impact assessment. The same biophysical information collected for the ungulate capability assessment can be applied to other aspects of an environmental assessment, thereby increasing its cost-effectiveness.

Development of this methodology is still ongoing, emphasis is currently being placed on defining the various ecotypes and distribution of wildlife

capability in British Columbia (i.e. Biotic Regions of British Columbia, in preparation). Models for the capability rating process are also under development. Users of this classification and its products are encouraged to contact the authors with suggestions for modification. Future revisions will be made to this publication to reflect the changes.

ANDERSON, J.W. and J.W. SPENCER. 1978. The winter feeding habits of winter forage for the cattle industry. J. Range Manage. 31: 111-125.

ANDERSON, J.W. and J.W. SPENCER. 1984. The distribution and abundance of animals. The University of Chicago Press, Chicago, Ill. 715 pp.

BARFIELD, A.M.T. 1974. The mammals of Canada. University of Toronto Press, Toronto, Ontario. 430 pp.

BIRCH, R. 1971. Environmental and capability for ungulate wildlife. Conservation Division, A.C. Farm Research Station, Victoria, B.C. 24 p.

BIRCH, R.C. 1966. Wildlife ecology. John Wiley & Sons, Inc. New York. 220 pp.

BIRCH, R.C. 1978. The use of the biophysical region and capability concepts in wildlife management. In British Columbia. Seven years on the Canadian Wildlife (in Biological and Classification, B.C. Wildlife, Victoria. 40 pp.

BIRCH, R.C. 1979. In preparation. Biotic regions of British Columbia. Survey and Resource Mapping Branch, Victoria, B.C.

BIRCH, R.C. and J.A. CHAMBERS. 1977. The Canadian experience in applying the biophysical region concept. In: Proceedings of the 1977 International Symposium on Wildlife Management, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025. 18/78 Final and Wildlife Survey, 2:5. 18/78, 18/79, 18/80, 18/81, 18/82, 18/83, 18/84, 18/85, 18/86, 18/87, 18/88, 18/89, 18/90, 18/91, 18/92, 18/93, 18/94, 18/95, 18/96, 18/97, 18/98, 18/99, 19/00, 19/01, 19/02, 19/03, 19/04, 19/05, 19/06, 19/07, 19/08, 19/09, 19/10, 19/11, 19/12, 19/13, 19/14, 19/15, 19/16, 19/17, 19/18, 19/19, 19/20, 19/21, 19/22, 19/23, 19/24, 19/25, 19/26, 19/27, 19/28, 19/29, 19/30, 19/31, 19/32, 19/33, 19/34, 19/35, 19/36, 19/37, 19/38, 19/39, 19/40, 19/41, 19/42, 19/43, 19/44, 19/45, 19/46, 19/47, 19/48, 19/49, 19/50, 19/51, 19/52, 19/53, 19/54, 19/55, 19/56, 19/57, 19/58, 19/59, 19/60, 19/61, 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References

- AMARAL, M. 1978. Black-tailed deer (*Odocoileus hemionus columbianus*) and forest reproduction: Blake Island Marine State Park, Washington. NW Sci. 52 (3): 233-235.
- ANDERSON, E.W. and R.J. SCHERZINGER. 1975. Improving quality of winter forage for elk by cattle grazing. J. Range Manage. 28 (2): 120-125.
- ANDREWARTHA, H.G. and L.G. BIRCH. 1954. The distribution and abundance of animals. The University of Chicago Press, Chicago, Ill. 782 pp.
- BANFIELD, A.W.F. 1974. The mammals of Canada. University of Toronto Press, Toronto, Ontario. 438 pp.
- BLOWER, D. 1973. Methodology: Land capability for ungulates. Wildlife Conservation Division. B.C. Land Inventory (C.L.I.). Victoria, B.C. 24 p.
- DASMANN, R.F. 1964. Wildlife biology. John Wiley & Sons Inc. New York. 229 pp.
- DEMARCHI, D.A. 1982. The use of the biophysical program and capability concepts in mapping ungulate habitat in British Columbia. Paper presented to the Canadian Committee on Ecological Land Classification, Banff, Alberta. 10 pp.
- DEMARCHI, D.A. In preparation. Biotic regions of British Columbia. Surveys and Resource Mapping Branch, Victoria, B.C.
- DEMARCHI, D.A. and T.W. CHAMBERLIN. 1977. The Canadian experience: An approach toward biophysical interpretation. In: Classification inventory and analysis of fish and wildlife habitat. Chairman A. Marmelstein. Proc. National Symposium, Phoenix, Arizona. pub. FWS/OBS 78/76 Fish and Wildlife Service, U.S. Dept. Interior, Washington, D.C. pp. 145-164.
- DEMARCHI, D.A. and B. FUHR. 1979. Biophysical land capability classification for wildlife (ungulates) generation II. A working report prepared by the Wildlife/Recreation Section. Resource Analysis Branch. Victoria, B.C. 20 pp.
- DEMARCHI, D.A. and A.P. HARCOTBE. 1982. Forage capability classification for British Columbia: A biophysical approach. APD Technical Paper 9. B.C. Ministry of Environment, Victoria, B.C. 50 pp.
- DEMARCHI, D.A., B.A. PENDERGAST and A.C. STEWART. 1980. Biophysical ungulate capability mapping in British Columbia. In: Symposium on census and inventory methods for populations and habitats. Co-eds.

- F.L. Miller and Anne Gunn, 1981. Northwest Section, The Wildlife Society Proceedings. Published by the Forest, Wildlife and Range Experimental Station, Univ. of Idaho, Moscow, Contribution No. 217. pp. 49-52.
- EDWARDS, R. 1956. Snow depths and ungulate abundance in the mountains of western Canada. *J. Wildl. Manage.* 20 (2): 159-168.
- FENGER, M. 1982. In press. A method for conducting soil survey at an intensity level 5. B.C. Ministry of Environment. Victoria, B.C.
- FUHR, B. 1980. A wildlife habitat assessment of the Pine/Moberly area of northeastern British Columbia. A working report prepared by the Wildlife Section, Terrestrial Studies Branch. Victoria, B.C. 29 pp.
- HILLS, G.A., D.V. LOVE, and D.S. LACATE. 1973. Developing a better environment. Ecological land-use planning in Ontario. A study of methodology in the development of regional plans. Graduate Dept. of Forestry. Univ. of Toronto. The Ontario Economic Council. 182 p.
- JENNY, H. 1941. Factors of soil formation. McGraw Hill Book Co. New York. 281 pp.
- KOWALL, R.C. 1971. Methodology: Land capability for forestry in B.C. Canada Land Inventory, ELUC Secretariat, Victoria, B.C. 18 pp.
- KRAJINA, V.J. 1969. Ecology of forest trees in British Columbia. Ecology of western North America. Vol. 2 (1): 1-146.
- LUCKHURST, A.J. 1975. Guidelines: Biophysical land capability classification for wildlife (ungulates). Resource Analysis Branch, Ministry of Environment. Victoria, B.C. Unpublished. 15 pp.
- MAJOR, J. 1951. A functional, factorial approach to plant ecology. *Ecol.* 32:392-412.
- MAPPING SYSTEMS WORKING GROUP. 1981. A soil mapping system for Canada. Revised, Land Resource Research Institute, Contribution No. 142. Agricultural Canada, Ottawa. 60 pp.
- MINISTRY OF ENVIRONMENT. 1982. Blue Paper No. 2: Public safety, fisheries and wildlife considerations. 2nd Edition. Parliament Buildings, Victoria, B.C. pp C1-C40.
- PEEK, J.M., R.E. LeRESCHÉ, and D.R. STEVENS. 1974. Dynamics of moose aggregations in Alaska, Minnesota, and Montana. *J. Mamm.* 55 (1): 126-137.
- PENDERGAST, B.A., R.A. HUNTER, and D.A. DEMARCHI. 1982. Data entry procedures for ecosystem description forms: wildlife. APD working report, B.C. Ministry of Environment, Victoria, B.C. 58 pp.

- PERRET, N.G. 1969. Land capability classification for wildlife. C.L.I. Report number 7. Canada Dept. of Regional Economic Expansion. Queens Printer for Canada. Ottawa. 29 p.
- ROWE, J.S. 1978. Revised working paper on methodology philosophy of ecological land classification in Canada. Ecological Land Classification Series, Number 7.
- RUNKA, G.G. 1971. Methodology: Soil capability for agriculture in B.C. ELUC Secretariat, Victoria, B.C. 25 pp.
- SONDHEIM, M., T. VOLD, and H. QUESNEL. 1982. Data entry procedures for ecosystem description forms. APD working report, B.C. Ministry of Environment, Victoria, B.C. 61 pp.
- SUMANIK, K.M. and D. DEMARCHI. 1977. Dispersion and relative abundance of moose in northern British Columbia. In: G.M. Lynch, chairman. Proceedings of 13th Annual North American Moose Conference and Workshop. Jasper, Alberta. 252-257 pp.
- TAYLOR, D.G. 1979. Editor. Land/wildlife integration. Ecological Land Classification Series No. 11. Lands Directorate, Environment Canada. 160 pp.
- THOMAS, J.W., H. BLACK, R.J. SCHERZINGER and R.J. PEDERSEN. 1979. Deer and elk. In J.W. Thomas, Technical Editor. 1979. Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. Agric. Handbook No. 553. U.S. Dept. Agric. Washington, D.C. 512 pp.
- VOLD, T. 1978. Reconnaissance biophysical soil inventories in British Columbia: A case study of the Northeast Coal Area. pp. 403-411. In: Integrated inventories of renewable natural resources: A national workshop, Tucson, Arizona, Jan. 8-12, 1978. 482 pp.
- WALMSLEY, M.E. 1976. Biophysical land classification in British Columbia: The philosophy, techniques and application, pp. 3-26. In: ecological (biophysical) land classification in Canada. Ed. by J. Thie and G. Ironside. Proc. 1st meeting Canada Committee on Ecol. (Biophysical) Land Class. Ecol. Land Class Series No. 1. Lands Directorate Environment Canada, Ottawa, Ontario. 269 pp.
- WALMSLEY, G. UTZIG, T. VOLD, D. MOON and J. VAN BARNEVELD. 1980. Describing ecosystems in the field. R.A.B. Technical Paper No. 2. B.C. Ministries of Environment and Forests. Victoria, B.C. 224 p.

PERKINS, H.M. 1952. Land classification for wildlife. Report number 10 of the Canadian Wildlife Service. Ottawa, 1952. 15 pp.

1954. Land classification for wildlife. Report number 11 of the Canadian Wildlife Service. Ottawa, 1954. 15 pp.

1955. Land classification for wildlife. Report number 12 of the Canadian Wildlife Service. Ottawa, 1955. 15 pp.

1956. Land classification for wildlife. Report number 13 of the Canadian Wildlife Service. Ottawa, 1956. 15 pp.

1957. Land classification for wildlife. Report number 14 of the Canadian Wildlife Service. Ottawa, 1957. 15 pp.

1958. Land classification for wildlife. Report number 15 of the Canadian Wildlife Service. Ottawa, 1958. 15 pp.

1959. Land classification for wildlife. Report number 16 of the Canadian Wildlife Service. Ottawa, 1959. 15 pp.

1960. Land classification for wildlife. Report number 17 of the Canadian Wildlife Service. Ottawa, 1960. 15 pp.

1961. Land classification for wildlife. Report number 18 of the Canadian Wildlife Service. Ottawa, 1961. 15 pp.

1962. Land classification for wildlife. Report number 19 of the Canadian Wildlife Service. Ottawa, 1962. 15 pp.

1963. Land classification for wildlife. Report number 20 of the Canadian Wildlife Service. Ottawa, 1963. 15 pp.

1964. Land classification for wildlife. Report number 21 of the Canadian Wildlife Service. Ottawa, 1964. 15 pp.

Appendix :

DESCRIPTIONS OF ENVIRONMENTAL CONDITIONS

Climate

Precipitation

Pa - rain shadow: a unit in which drought tolerant plants become established due to a combination of high evapotranspiration and low precipitation caused by macrorelief (rain shadow). Plants that occur here are tolerant of more xeric conditions than are the plants of adjacent areas.

Snow

Sh - high snow depth: a unit having snow depth usually greater than 1m and/or a long period of snow cover. These sites are not usually potential winter range except where snow is dense enough to support the animals.

S1 - low snow depth: a unit having low snow depth (usually less than 1/2 m) and/or a short period of accumulation not significantly restricting to ungulates.

Sm - moderate snow depth: a unit having moderate snow depth and/or a moderate period of snow cover, not influenced significantly by solar radiation or wind action. Snow accumulation is approximately 1/2 to 1 m in depth and affects some ungulate species.

Sp - snowfields and glaciers: a unit of permanent snow and ice. (These areas have no ungulate forage).

Ss - intensified solar radiation: a unit in which snow accumulation is significantly reduced through exposure to solar radiation on southerly aspects. Ungulate wintering capability is usually higher than in adjacent units.

Sw - windswept snow: a unit of low snow depth due to wind action in moderate or deep snow areas, commonly found on high elevation ridges and slopes. Ungulate use is higher than in adjacent units.

Temperature

Ta - alpine aridity: a unit at high elevation that is subject to aridity in summer as a result of extreme evapotranspiration and wind action resulting in reduced forage production.

Tc - cold air layer: a unit where extreme and persistent freezing temperatures occur, typically under temperature inversions. Ungulate wintering capability is usually restricted on these units.

Tf - frost pockets: a unit subject to a high frequency of freezing temperatures relative to the surrounding terrain. Such areas usually occur in small valleys and depressions subject to cold air drainage and are distinguished by different vegetation. Ungulate use of such areas is often less than on adjacent units.

Th - high temperatures: a unit subject to high summer heat temperatures causing great evapotranspiration resulting in xeric plant communities (grasslands). Ungulate capability is usually high for grazing species.

Tw - warm air layer: a unit affected by relatively warm air, typically above temperature inversions. Ungulate wintering capability is usually enhanced compared to adjacent units.

Wind

We - wind exposure: a unit exposed to persistent local winds resulting in the establishment of more xeric tolerant plants than in surrounding areas.

Anthropogenic Factors

Hc - cultivated land: a unit that has a significant portion of area occupied by intensive cultivation, which has permanently altered native forage potential.

Hh - draw-down zone: a unit in the area between full pool and low pool on reservoirs. Wildlife capability and the character of the land base is altered on such units.

Hi - industrial development: a unit that has a significant proportion of its area occupied by industrial development such as tailings ponds, spoil areas or open pit mines.

Hr - roads or railways: a unit that has a significant proportion of its area occupied by transportation routes such as major highways and railways.

Hu - urban development: a unit that has a significant proportion of its area occupied by permanent urban development.

Landforms and Terrain

La - avalanche tracks: a unit with modified vegetation as a result of avalanches. Forage production is generally enhanced because of the maintenance of early seral stages.

Le - soil erosion: a unit that has been eroded or where erosion potential is high. Processes range from minor gulleying to sheet erosion. Wildlife use may be limited due to lack of forage production.

Lf - floodplain: a unit of flat land bordering a river subject to periodic flooding resulting in moisture and nutrient loving vegetation associations. Erosion and deposition frequently maintains patches of early seral vegetation with desirable forage species.

- Li - fresh water inundation: a unit subject to periodic natural inundation and or high water table resulting in the establishment of marshy or stunted vegetation. Ungulate use is restricted to water tolerant species or non-inundated periods.
- Ll - level land: a unit that is flat with slopes less than 2°.
- Lr - rolling or hilly land: a unit having complex slopes between 5° and 30° in a generally low relief area. This pattern enhances cover for some ungulate species.
- Ls - steep slopes: a unit with slopes greater than 25° often influencing use by ungulates. Such sites may provide escape terrain for mountain sheep and mountain goats.
- Lt - tidal inundation: a unit in estuaries, lagoons and salt marshes. Such areas may be important for ungulates wintering in high snow-fall coastal zones.
- Lw - mass wasting: a unit containing extensive areas of unstable slopes. Forage production may be reduced.

Soils

- Ea - alpine tundra soils: a unit of virtually treeless high elevation mountains or plateaus. These areas often include considerable exposed bedrock and frequently have capability to support mountain goats, sheep and caribou.
- Eb - alkaline soils: a unit of strongly alkaline soil due to high lime or other basic salts. Only alkaline tolerant plants can grow on these units.
- Ed - open forest soils: a unit of upland soils which have deep or moderately deep, medium textured morainal or colluvial materials,

which are well-drained. These areas have either low precipitation or high evapotranspiration and are typically open forest or a transition forest/grassland. Wildlife capability is generally good.

Ef - dense forest soils: a unit of upland soils which have deep or moderately deep, medium textured morainal or colluvial materials, which are well drained. These areas have either high precipitation, usually in the form of snow, or low evapotranspiration, and are typically dense forest. Forage production varies with seral state.

Eg - grassland soils: a unit where a grassland becomes established, usually upland areas having deep or moderately deep medium textured morainal or colluvial materials. These areas have low precipitation and high evapotranspiration and typically include xeric tolerant shrubs and herbs.

Eh - moist soils: a unit of mineral soil having poor drainage. These soils either receive seepage water or have seasonally high water tables, and support mainly moisture tolerant plants.

Ek - krummholz forest soils: a unit of interrupted forest cover of stunted subalpine trees which is transitional to alpine tundra. These areas are typically found on convex or straight, moisture shedding slopes which are exposed to persistent wind and cold climate. Summer and winter ungulate capability is variable.

El - deep lacustrine soils: a unit having fine textured soils developing from lake deposits.

Em - subalpine meadow soils: a unit of subalpine meadow occurring due to a combination of cold air temperature, imperfect to poor water drainage and cold air drainage. These areas are often concave in

shape and receive moisture from upper slopes. The meadows are usually surrounded by subalpine forest and support abundant herbaceous growth which provide important summer range for ungulates.

Co - organic soils: a unit with poor drainage dominated by fens and bogs which may have high capability for certain species.

Er - bedrock: a unit where bedrock is at or near the surface. Vegetation production is hampered due to lack of rooting material, and the mobility of some ungulate species is impaired.

Es - saline soils: a unit of strongly saline soil. Only salt tolerant plants grow on these units.

Et - talus: a unit dominated by talus. Generally little vegetation develops on talus due to its continuous downslope movement and its extremely poor moisture holding capacity.

Ex - dry soils: a unit dominated by very dry soils occurring as a result of poor moisture holding capacity due to texture. These soils may form on colluvial slopes or coarse textured morainal materials. The soils may be shallow to rock. Vegetation is generally sparse when compared to that on surrounding land units.

Ew - deep fluvial deposits: a unit dominated by flat-lying, coarse textured materials occurring in deep inactive fluvial deposits. Vegetation is generally sparse when compared to that on adjacent units. These areas differ from 'Ex - dry soils' in landform and management interpretation.